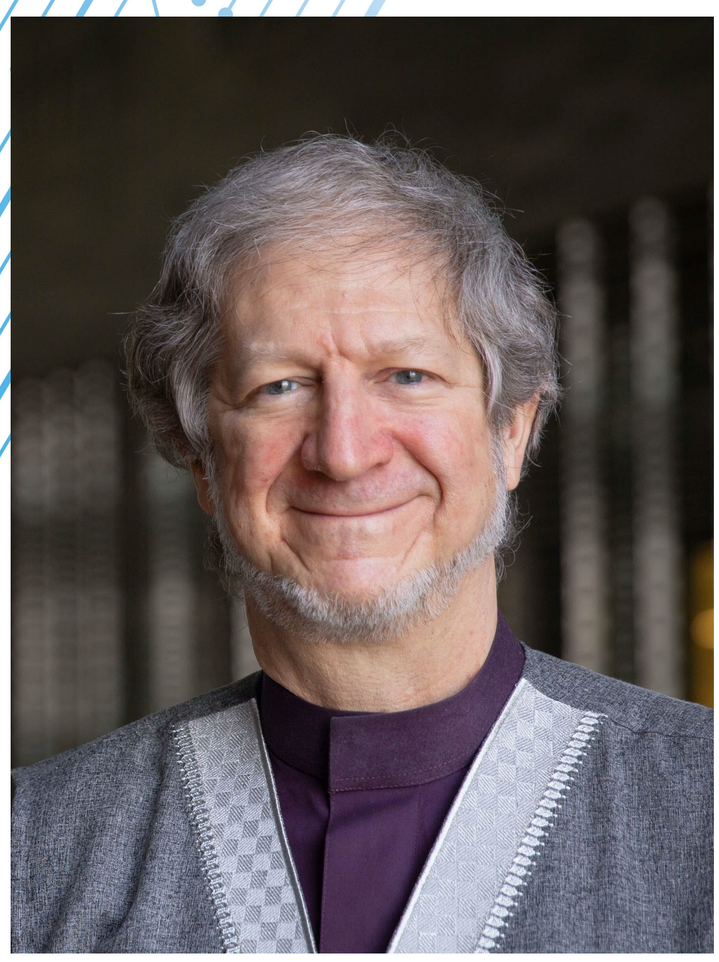
MASTERWORKS
Lecture Series

CASC



Thursday, December 16, 2021

1:00 P.M.

WebEx

Dr. David Keyes

King Abdullah University of Science and Technology

Nonlinear Preconditioning for Nonlinearly Stiff Multiscale Systems

Abstract:

Nonlinear preconditioning transforms a nonlinear algebraic system to a form for which Newton-type algorithms have improved success through quicker advance to the domain of quadratic convergence. We place these methods, which go back at least as far as the Additive Schwarz Preconditioned Inexact Newton (ASPIN, 2002), in the context of a proliferation distinguished by being left- or right-sided, multiplicative or additive, and partitioned by field, subdomain, or other criteria. We present the Nonlinear Elimination Preconditioned Inexact Newton (NEPIN, 2021), which is based on a heuristic "bad/good" heuristic splitting of equations and corresponding degrees of freedom. We augment basic forms of nonlinear preconditioning with three features of practical interest: a cascadic identification of the "bad" discrete equation set, an adaptive switchover to ordinary Newton as the domain of convergence is approached, and error bounds on output functionals of the solution. Various nonlinearly stiff algebraic and model PDE problems are considered for insight and we illustrate performance advantage and scaling potential on challenging two-phase flows in porous media. Joint work with Lulu Liu, Li Luo, Xiao-Chuan Cai, and others.

Bio:

David Keyes directs the Extreme Computing Research Center at KAUST, where he was founding Dean in 2009 and holds appointments in Applied Mathematics, Computer Science, and Mechanical Engineering. He is also Adjunct Professor at Columbia, where he formerly held the Fu Foundation Chair. He works at the interface between parallel computing and partial differential equations and statistics, with a current focus on exploiting data sparsity. Keyes led scalable solver projects in the SciDAC and ASCI programs of the US DoE, directed university collaboration programs for US DoE and NASA institutes, and taught at Columbia, Old Dominion, and Yale. He is a Fellow of SIAM, AMS, and AAAS. He has been awarded the ACM Gordon Bell Prize, the IEEE Sidney Fernbach Award, and the SIAM Prize for Distinguished Service to the Profession. He earned a B.S.E. in Aerospace and Mechanical Sciences from Princeton and a Ph.D. in Applied Mathematics from Harvard.

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